Space Weather Technical Forecast

Issued on Sunday, 06 March 2022 at 13:27 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

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Space Weather Forecast Headline: Chance of further G1/Minor Geomagnetic Storms initially. Daily Chance of R1 Minor Radio Blackouts throughout.

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Solar activity was Low over the period, with occasional C-class flares observed at GOES 16. These flares peaked with a long-period C2.7 at 05/2022 UTC from AR2962 (Bxo/Beta) in the sun's northeastern quadrant.

There are currently three other numbered sunspot regions on the visible disc, plus a weak unipolar unnumbered region in the southeast. AR2958 (Bxo/Beta) is the sunspot responsible for the M2.0 X-ray flare on 02 March and the possible CME in the forecast during the upcoming UTC day of Sunday 06 March. 2960 in the southeastern quadrant is the largest region on the disk, which appears to be an Ehi/Beta. AR2957 is a Dsi/Beta in the southwest.

There are currently numerous filaments on the disc, some of these have been mobile in the past 24 hours. Some CMEs have been analysed as follows-

A northeast-directed CME of uncertain origin, seen in both Lasco and STEREO A COR2 imagery around 05/0300UTC. This event is especially low confidence, however an Earth-bound component is possible with a provisional arrival time of 10/2100 UTC forecast.
A dimming and CME seen heading northwest in Lasco and STEREO from the vicinity of Ex-2955 after 05/1720 UTC. Modelling for this event indicates no Earth-bound component.
And finally yet another dimming from the southeastern quadrant, immediately south of AR2960 at 05/1830 UTC. Imagery from this event is inconclusive however, given the location, it is unlikely to have an Earth-directed component.

The M2.0-associated CME from AR2958 on 02/1739 UTC has been reanalysed and may give a glancing blow, most likely around 07/0300 UTC, though ensemble output shows a wide spread of arrival times with the earliest around 06/1200 UTC. Confidence is low with this forecast.

Solar Wind / Geomagnetic Activity: The solar wind, as measured by DSCOVR at L1, showed a resurgent negative polarity fast wind regime in the period, possibly a transition between the expected coronal holes CH61 and CH62, or perhaps variation within one such feature. The phi angle was accordingly mostly negative (towards the sun).
The solar wind speed has been elevated to peak near 560 km/s at 06/0001 UTC, towards the end of the period it settled down around 520 km/s. The solar wind density started at average values, before increasing above average around 13 ppcc. The phi angle was predominantly negative (towards the Sun). The IMF was highest at the start of the period, peaking at 12nT, with below average numbers for most of the period. The north-south component of the IMF (Bz) varied between -12nT and +6nT with long periods negative.
The net result of the above solar wind measures was resurgent geomagnetic activity, with G1/Kp5 minor geomagnetic storms observed between 05/1800-2359 UTC and 06/0600-0900 UTC.

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Energetic Particles / Solar Radiation: The high energy proton flux (greater than 10MeV) measured at GOES 16 was at Background levels.
The high energy electron flux (greater than 2 MeV) ranged between Normal Background and Moderate levels. The corresponding 24-hour integrated electron fluence remained well below the Active (1e8 integrated pfu) threshold, with an increase after 06/0001 UTC evident. The 06/0001 UTC observation was 2.37e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Solar activity is Expected to be Low, with further occasional C-class flares and a Chance of M-class flares. No significant regions are expected to rotate onto or leave the visible disc through the period.

Solar Wind / Geomagnetic Activity: There are otherwise two parts to the geomagnetic forecast: the current coronal hole high speed stream(s) from CH61 and CH62, and also a possible glance from a CME emitted on 02/1739 UTC in relation to the M2.0 from AR2958. There remains a Chance of G1/Minor Storm from the current high speed stream on day one (6 March) and early day 2 (7 March), with this risk further bolstered as a result of the uncertain influence of the M2.0-associated CME. Activity should wane from late on day 2 (7 March), becoming most reliably Quiet from day 3 (8 March), but with the caveats should the CME that is expected to arrive on day 5 (10 March) arrive early on day 4 (9 March).

Energetic Particles / Solar Radiation: The high energy (greater than 10 MeV) proton flux is expected to remain at Background levels.
The high energy electron flux is expected to increase, though this is dependent on any CME arrivals. In the absence of significant CME activity or further geomagnetic storms electron flux levels will likely slowly rise, exceeding the 1000 pfu high level during the diurnal maximum. The chances of Active fluence is expected to rise through the period with REFM considered to be under-estimating these likely increases.

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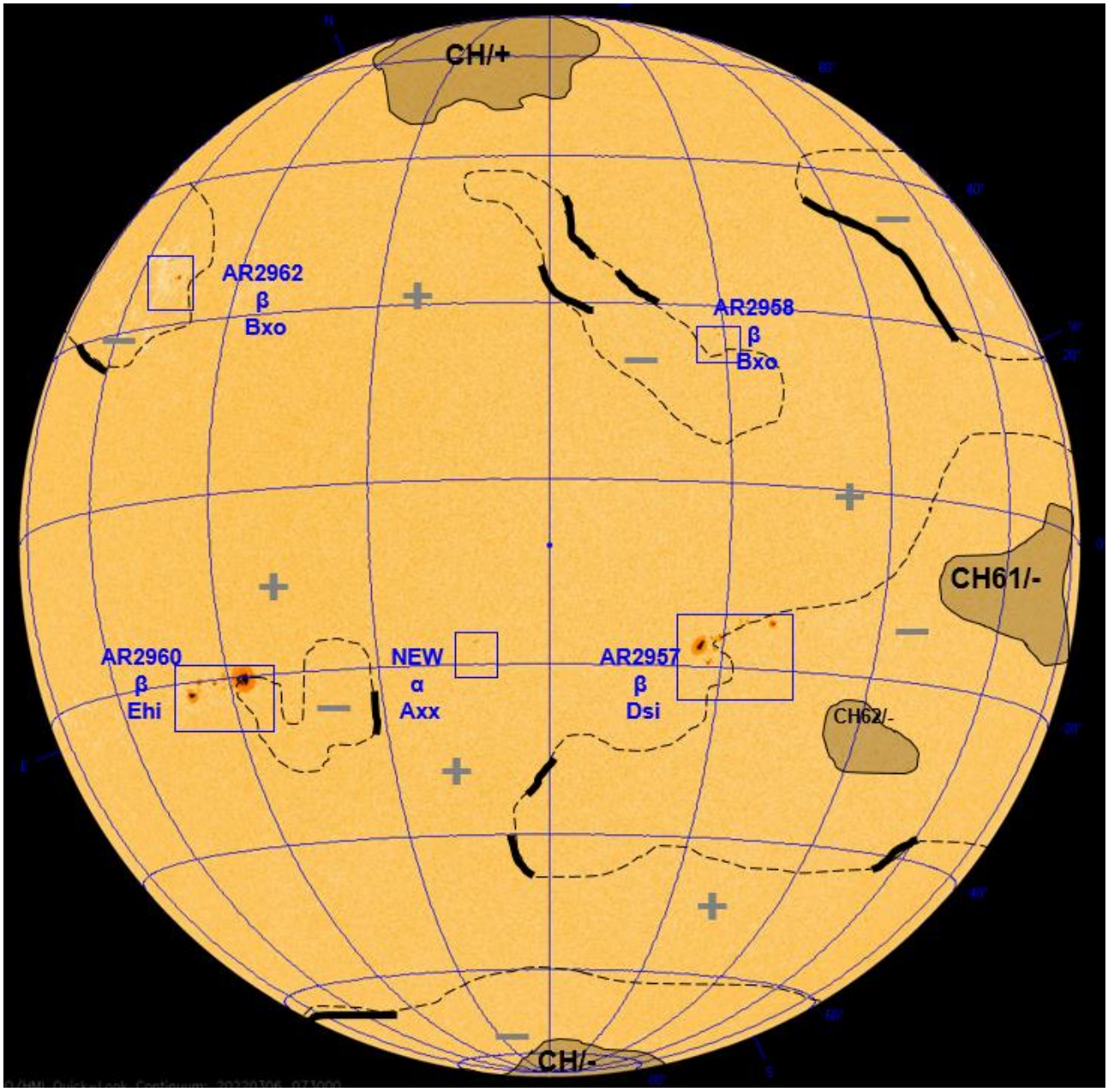
Figure 1. Solar Analysis Valid 06/0800 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Met Office Space Weather Technical Forecast

Geomagnetic Storms:

There are two main aspects of the geomagnetic forecast - firstly the current high speed stream from the combination of CH61 and CH62; and secondly, the possible marginal effects from the 02/1739 UTC M2.0 CME that should mainly pass behind the Earth in the track of its orbit.
CH61 and CH62 underwent an unexpected increase in many solar wind measures through the UTC day of Saturday, leading to Minor Storm intervals extending into Sunday 6 March. This increase is expected to begin to wane into day 2 (7 March). Being near the vernal equinox, these negative coronal hole features should make further G1/Minor geomagnetic storms possible, although the prospects of this should fall from day 2 (7 March).
Modelling of the 02/1739 UTC M2.0 CME revealed some MOSWOC Enlil ensemble members with 'hits' on or after 06/1200 UTC, however closer inspection of their perturbations suggests that these are not favoured scenarios (e.g. excessively wide CME cone angles - compared to observed imagery) Enlil suggests the most likely arrival time is 07/0300UTC. Any impacts from a glancing blow from this CME are expected to be relatively weak, though this is included in the 20% probability of a G1 minor geomagnetic storm on day 2 (7 March).

There remains a chance of further G1 geomagnetic storms on day 1, (6 March) and perhaps early on day 2 (7 March). The most reliably Quiet conditions should then occur on day 3 (8 March). The risk increases slightly on day 4 (9 March) should the CME forecast to arrive on the 10th arrive early.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	Yes	40	20	5	10
Strong	G3	No	1	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Geomagnetic Activity - Earthbound Coronal Mass Ejections

Date/time 21.5R (UTC)	Halo: Full or Partial	Source	Source Location	Estimated Speed	Estimated Arrival Time	Comments
03/0601UTC	Partial	AR2958	N05E39	270km/s	07/0300UTC	Low confidence with unusually wide range for possible arrival time.
06/0650UTC	Partial	Ex2955	N18W75	282km/s	10/2100UTC	Low confidence due to difficulties analysing CME.

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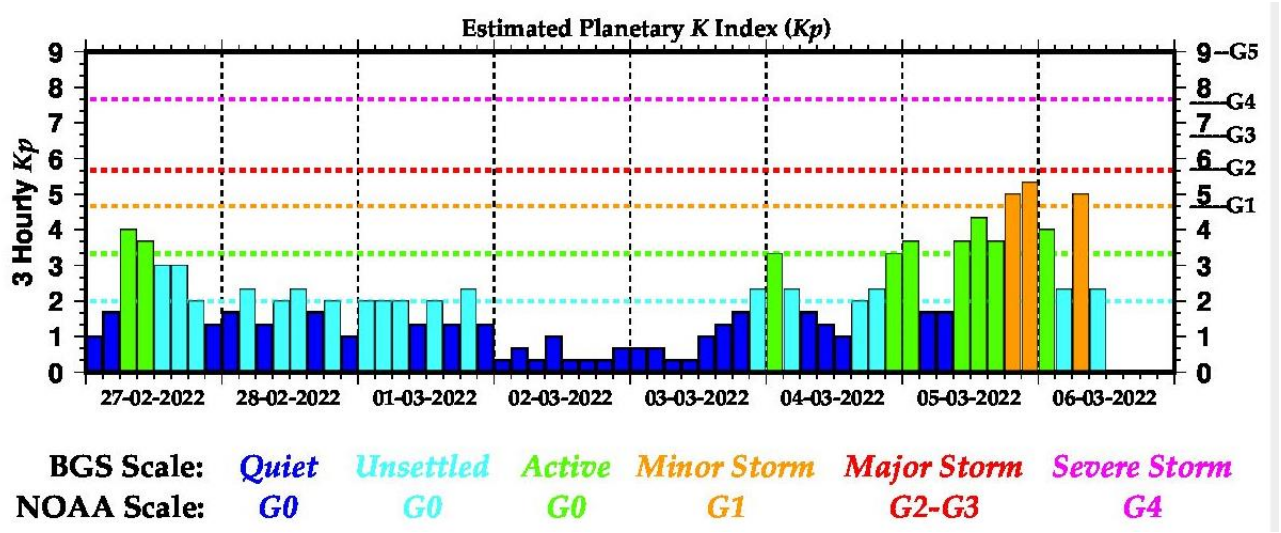
Figure 2: BGS Kp



Radio Blackouts - X-Ray Flares:

Barring significant development, the contribution to X-ray flare risk from the current crop of front-sided sunspots is expected to remain largely unchanged in the four-day period, with no new returning regions, although there is now starting to be hints of bright flux around three days away in the northeast (on STEREO A EUVI near 120E).
AR2960 in the southeast appears to be the most active of the current sunspot groups, although perhaps not to the degree that a growing trend in an Ehi/Beta may suggest. Largely as a result of this region's contributions, the daily risk of C-class flares is rated at 80-90% throughout, with M-class now 25%, increased slightly due to AR2957's stature.

X Ray Flares	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC)	Day 2 (00-24 UTC)	Day 3 (00-24 UTC)	Day 4 (00-24 UTC)
Probability			(%)	(%)	(%)	(%)
Active	R1-R2 M Class	No	25	25	25	25
Very Active	R3 to R5 X Class	No	1	1	1	1

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Solar Radiation Storms - (High Energy Protons):

The high energy proton flux (10MeV) measured at GOES 16 is currently at Background levels.
The slightly increasing trend in the probabilities is the result of the centre-disc sunspots' nominal potential to produce S1+ events should they flare as they continue westward into slightly more geo-effective positions.

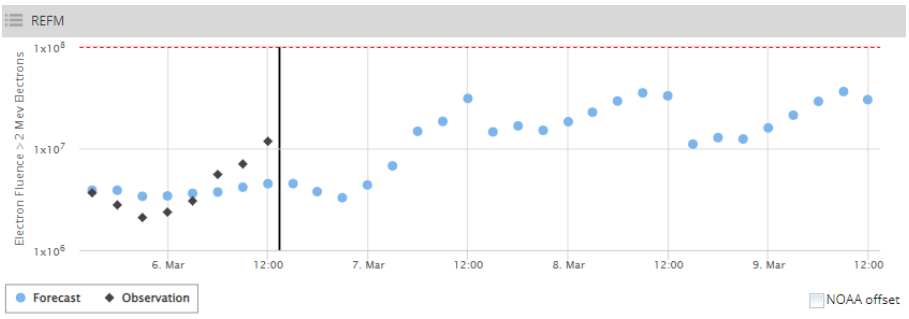
Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ S1**	No	1	2	2	2
Very Active	**≥ S3 ***	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

The high energy electron flux (greater than 2MeV) has been at Normal Background to Moderate levels during the past 24 hours.
The high energy electron flux is expected to rise over the next few days. Notwithstanding any possible CME influences. The 1000pfu High threshold is expected to be breached near the diurnal maximum.
This, in turn, should result in an increase in fluence levels, with REFM considered to be underestimating the possibility of the 1e8 integrated electron fluence Active level being reached.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	**≥ 2 MeV ≥ $1x10^8$**	No	10	40	50	60
Very Active	**≥ 2 MeV ≥ $1x10^9$**	No	1	1	1	1

Figure 3: Observed fluence increasing quicker than REFM forecast.



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